BRIEF COMMUNICATIONS

SHOULD THE BIDIRECTIONAL GLENN PROCEDURE BE PERFORMED THROUGH A THORACOTOMY WITHOUT CARDIOPULMONARY BYPASS?

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The bidirectional Glenn procedure, that is, an end-to-side anastomosis of the superior vena cava (SVC) to the right or left pulmonary artery, is now routinely performed for various congenital heart defects mainly involving an eventual 1-ventricle repair. It may be performed as an interim step in the pathway to a Fontan-type circulation, as part of a 1.5-ventricle repair, and sometimes to reduce right ventricular volume overload. The procedure is usually undertaken via a midline sternotomy with cardiopulmonary bypass (CPB). For completion of a total cavopulmonary connection, a further sternotomy with CPB is again necessary. To avoid the risks of these procedures, we report the case histories of 6 patients who underwent a bidirectional Glenn shunt and 1 patient who underwent a classic Glenn shunt through a right thoracotomy without CPB.

Patients and methods. Six of the 7 patients had pulmonary atresia with intact ventricular septum and 1 patient had classic tricuspid atresia with pulmonary stenosis (Table I). All patients had undergone a left-sided modified Blalock-Taussig shunt in the neonatal period and 1 patient had undergone an open pulmonary valvotomy. One patient underwent a classic Glenn procedure and 6 patients had the bidirectional Glenn procedure performed. The median age at operation was 16 months (range 11 months–3 years). An internal jugular line was placed before the operation in all patients to measure the SVC pressure. The preoperative systolic blood pressure was calculated as the average of 3 different measurements before the SVC and right pulmonary artery were clamped. A right posterolateral thoracotomy was performed in all patients. After dissection of the SVC and right pulmonary artery, the azygos vein was divided and the SVC was clamped in its proximal and distal sections and divided. No shunt was used during the clamping of the SVC. The highest right internal jugular pressure reached during clamping of the SVC is shown in Table I, with a median value of 26 mm Hg (range 19-65 mm Hg). The systolic blood pressure during clamping of the SVC was calculated as the mean of 3 different measurements during that period. The median clamp time was 11 minutes. The transcranial pressure during clamping was measured by calculating the difference between systolic blood pressure and the right internal jugular pressure. The median transcranial pressure was 71 mm Hg (range 15-91 mm Hg). In 3 patients the systemic blood pressure was raised by using dopamine and an α-agonist (metaraminol) with a view to maintain a gradient of more than 30 mm Hg. This gradient was chosen on empiric grounds to ensure cerebral perfusion. No active cooling of the patients was performed, but the temperature in the operating room was kept at 17°C. After the procedure, the patient was actively warmed with a hot air blanket (Bair Hugger blanket; Augustine Medical, Inc, Eden Prairie, Minn) to 36°C. All patients made a good postoperative recovery. No neurologic deficits were detected. Three patients have undergone completion of a total

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Table I. *Patients' characteristics*

Diagnosis	*Age at operation (mo)*	*Clamp time (min)*	*Operative IJP (mm Hg)*	*Operative BP (mm Hg)*	*TCP (mm Hg)*
PA/IVS	22	8	50	95/50	45
PA/IVS	11	11	22	95/50	73
PA/IVS	16	13	26	78/44	52
PA/IVS	16	14	19	110/56	91
PA/IVS	36	12	29	100/51	71
PA/IVS	23	6	65	80/45	15
TA/PS	12	15	23	96/52	73

PA/IVS, Pulmonary atresia/intact ventricular septum; *TA/PS,* tricuspid atresia/pulmonary stenosis; *IJP,* internal jugular pressure; *BP,* blood pressure; *TCP,* transcranial pressure.

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cavopulmonary connection at a median follow-up of 2.1 years and 4 are currently well and awaiting complete repair at a median follow-up of 1.6 years.

Discussion. Performing the bidirectional Glenn shunt through a thoracotomy has the advantages of avoiding redo sternotomy and subjecting the patient to CPB. This is particularly applicable if no additional intracardiac operation is needed. It has the disadvantage of subjecting the brain to high venous pressures. If this is associated with low systemic blood pressure, the resultant low transcranial pressure can increase the risk of neurologic damage. We used pressor agents to increase the systemic arterial pressure to increase the transcranial pressure and were also conscious of the need to complete the anastomosis in the shortest possible time. The maximum clamp time was therefore 15 minutes. In practice, this puts some pressure on the surgeon to operate reasonably swiftly. Lamberti and colleagues[1] reported on 7 patients who underwent the cavopulmonary shunt operation without CPB; six of these operations were performed via a right thoracotomy. They used an intraoperative shunt to prevent SVC hypertension during clamping. When the SVC was occluded, the shunt resulted in a 15–mm Hg drop in SVC pressure. We have found the use of a shunt cumbersome and inefficient in lowering the SVC pressure. The classic Glenn shunt used to be performed through a thoracotomy without CPB.[2] Glenn and colleagues, in their original report, had partially occluded the SVC. However, in practice many of the shunts used to be performed with total occlusion of the SVC. To our knowledge there are no reported cases of neurologic injury from that era. It may be that knowledge of brain protection was too scant to appreciate the potential damage to the brain. We believe that in selected cases performing the bidirectional Glenn shunt through a right thoracotomy without CPB has a role. We did not detect any neurologic complications, but this remains a concern, particularly if the SVC clamp time is prolonged.

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Commentary

The report by Jahangiri and associates describes the case histories of 7 patients with simple forms of single ventricle (6 with pulmonary atresia with intact ventricular septum; 1 with tricuspid atresia) who underwent placement of Glenn shunts (1 classic; 6 bidirectional) without the use of either cardiopulmonary bypass (CPB) or some form of decompressing shunt. The authors believe that their patients did not have neurologic complications and therefore suggest that this is a reasonable method for performing the Glenn shunt.

A fundamental problem with this report is that the authors are suggesting a new technique that puts the brain at risk, and yet they have failed to document the safety of the method in adequately protecting the brain. Many similar reports have appeared in the surgical literature regarding techniques such as retrograde cerebral perfusion without careful studies to document safety of the brain. The only statement made by Jahangiri and colleagues is that "no neurologic deficits were detected." In a surgical report, I interpret this statement to mean that the patient was neither comatose nor densely hemiplegic: that is, the patient had not had an "end-of-the-bed stroke." Ideally, these patients should have undergone careful examination both before and after the procedure by a neurologist who might have detected subtle changes in coordination and visual fields, for example, deficits that are unlikely to be noticed by surgeons.

Jahangiri and coworkers made an empiric decision to attempt to maintain the cerebral perfusion pressure, which they define as the difference between the systolic arterial pressure and the mean jugular venous pressure, as high as at least 30 mm Hg. Unfortunately, this is indeed, as the authors state, an entirely "empiric" judgment for which no reference is given. The authors might have considered using new monitoring modalities such as near-infrared spectroscopy or transcranial Doppler assessment of cerebral blood flow velocity to supplement their empiric blood pressure monitoring. However, even these techniques are unproven for monitoring the brain in such circumstances.

Jahangiri and colleagues are not alone in suggesting that various forms of cavopulmonary anastomosis can be performed without CPB. Petrossian and associates[1] are currently recommending that the extracardiac conduit Fontan procedure be undertaken without CPB with the use of a veno-venous shunt system. They believe that the deleterious effects of CPB justify this approach. Their technique and similar veno-venous shunt procedures proposed by others for the bidirectional Glenn shunt carry the risk that the quality of the cavopulmonary anastomosis may be compromised by this approach. These techniques also may limit cerebral blood flow in children who are already cyanosed. Their use, therefore, could result in a cerebral hypoxic/ischemic injury. It is essential that those proposing such methods work closely with their neurologists to document the absence of even subtle neurologic insults. Ideally, these children should also undergo psychometric or developmental assessment by psychologists, as well as careful intraoperative monitoring of the brain with the most sophisticated methods available.

There is no question that current methods for support of the patient during cardiac surgery, such as CPB, leave much to be desired. Jahangiri and colleagues are to be congratulated for seeking an innovative method for minimizing such injury. I await with interest their careful documentation of the safety for the brain of their intriguing new method of performing the Glenn shunt.

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